Jan. 29, 1946. H. G. McDOWELL 2,393,922

CALCULATOR

Filed June 9, 1943 2 Sheets-Sheet 1

Fig. 1.

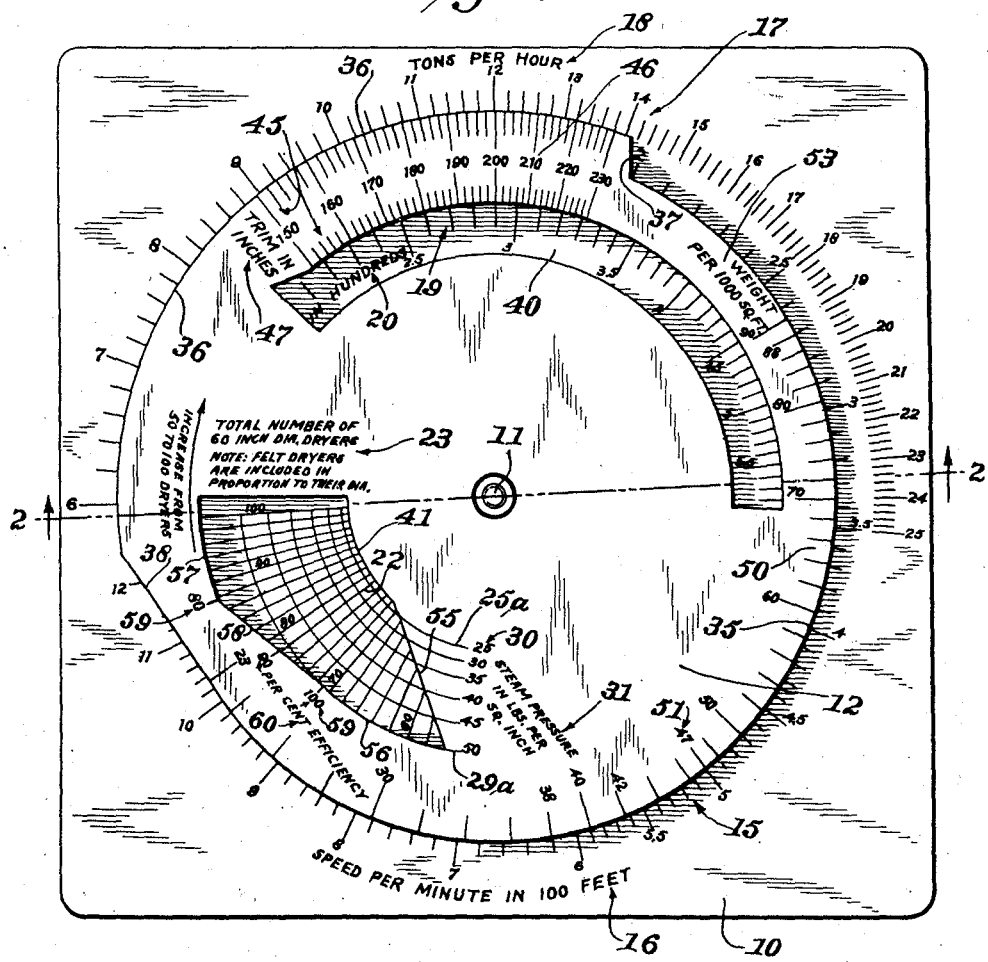
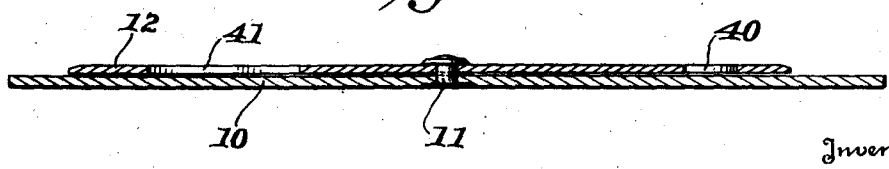


Fig. 2.



Inventor:

Harvey G. McDowell,

By Cushman Darby & Cushman.

Attorneys.

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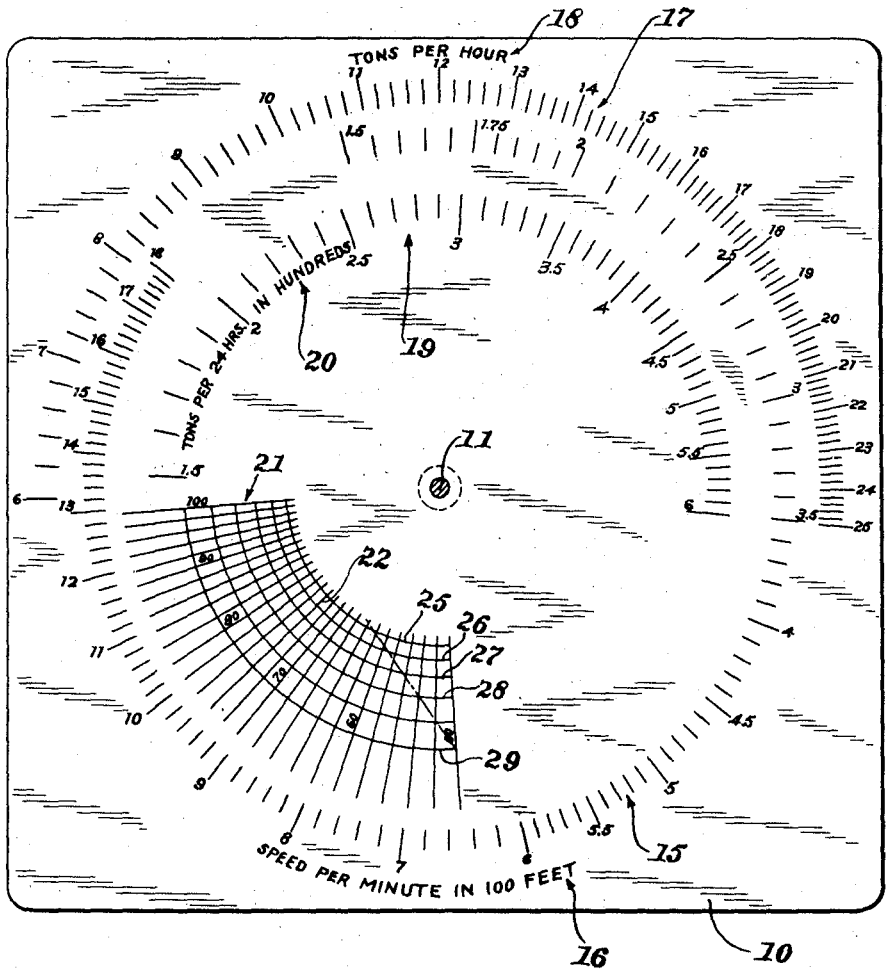
Fig. 3.



Inventor:

Harvey G. McDowell,

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Attorneys.

Patented Jan. 29, 1946 2,393,922

UNITED STATES PATENT OFFICE

2,393,922

CALCULATOR

Harvey G. McDowell, Wilmington, Del.

Application June 9, 1943, Serial No. 490,185

3 Claims. (Cl. 235—84)

The present invention relates to a calculating device, particularly adapted for use in paper-making plants in connection with the drying end of a paper-making line.

In the production of paper, a continuous web is delivered from the wet end of the line, to a plurality of driers, so that the wet web is rapidly dried as it moves continuously through the apparatus. In the drying of the paper, there are a number of variable features which must be taken into account. In the past, it has been the practice to control these variables by the skill and experience of the operators or by complicated and involved mathematical calculations, or both.

The primary object of the present invention is to provide a calculating device which will automatically and expeditiously indicate to the operator, the relationship between these variable factors and which will instruct him, substantially instantaneously, exactly how each variable factor under his control should be adjusted for maximum efficiency of the paper-producing apparatus.

Operators skilled in the paper-making art appreciate that a predetermined amount of heat must be applied to a predetermined amount of wet paper web, in order effectively to dry the same. The amount of heat applied to a moving web is a function of the number of drying rolls in the drying end of the line, the temperatures of the rolls and the speed of movement of the sheet. As the weight of the sheet increases or decreases, one or more of these factors must be increased or decreased. Similarly, if the weight remains constant and one or another of the variables changes, the others, or at least one of them, must be correspondingly changed. For instance, if the temperature of the rolls is decreased, while the weight of the web remains constant, the speed of movement of the web must be decreased or the number of rolls employed in the line increased. Similarly, if the number of rolls is decreased, for one reason or another, the temperature of the remaining rolls must be raised or the speed decreased.

When the wet end of the machine is changed from one weight of paper to another, corresponding adjustments must be made in the number of drying rolls employed, the temperature to which the rolls are heated, and/or the speed of movement of the web. As stated above, these adjustments have, heretofore, been made as a result of the instinctive skill of the operator and by mathematical calculation, or both.

The present invention provides an apparatus whereby the relationship between these variable factors can be determined, substantially instantaneously, thereby avoiding reliance upon the skill of the operator and entirely eliminating the necessity for mathematical calculations.

The invention also provides means for calculating the production rate of the mill in tons per hour and tons per twenty-four hours, depending upon the weight of the paper, its speed of movement through the driers, and the trim or width of the finished sheet. If the weight of the web and its speed of movement are known, the calculator of the present invention immediately indicates the production in tons per hour and in tons per twenty-four hours of finished product, for all possible trim widths, thereby eliminating involved, complicated and laborious calculations. Conversely, if a particular production goal is set, for a particular trim and weight of paper, the calculator of the present invention will substantially instantaneously advise the operator as to the speed of movement of the web required to meet this goal. Finally, and without manipulating the calculator, the steam pressure (temperature) and the particular number of rolls needed in operation in the line to maintain this production rate may be immediately determined.

Thus, the object of the present invention is to provide a calculator which, by simple adjustment, indicates all possible combinations of adjustments and variations of the several variable factors involved in the operation of drying paper.

Since these variable factors bear a direct ratio or a direct inverse ratio to one another, the calculator of the present invention has been based upon the principle of the slide rule, modified so as to make it correspond to the variables involved, whose ratios have been determined by careful observation and calculation. These variables and their relationship to each other have been translated into logarithmic scales, juxtaposed upon a stationary base or stock and a movable member or slide. For the sake of convenience, and conservation of space, the divisions of the scales have been arranged on radii of a circle, spaced apart in degrees and functions of degrees generally corresponding to logarithmic spacings on a straight slide rule. The movable member has similar scales thereon, and is mounted for rotation relative to the base.

A preferred form of the invention is illustrated in the accompanying drawings, but it must be understood that the invention is not limited to the arrangement of parts shown therein and described below, since an almost infinite number of variations in structure and scales can be substituted by those skilled in the art, from a con-

sideration of this disclosure. All such variations as come within the scope of the appended claims are intended to be included.

In the drawings:

Figure 1 is a plan view of the calculator of the present invention.

Figure 2 is a section on line 2—2 of Figure 1, and

Figure 3 is a plan view of the base or stock, with the rotatable slide removed.

The calculator comprises a base 10 which may be made of any suitable sheet material, such as metal, cardboard, celluloid, synthetic resin or any other plastic. The base carries a stud 11, upon which the slide or movable member 12, made of similar sheet material, is mounted for rotation.

The base is provided with a plurality of scales arranged on concentric arcs, all struck about the center of the stud 11 and each having the individual markings thereof spaced varying distances from one end, in accordance with the principle of the well known logarithmic scales used in slide rules.

For purposes of making the calculations described above, these scales may include a scale 15, having numerals associated with the various markings to indicate the speed of travel of the paper web in units of 100 feet per minute, as indicated by the legend 16 adjacent the scale. A similar logarithmic scale 17, which may be spaced radially outwardly with respect to the scale 16, may have markings to indicate tons of paper produced per hour, and an appropriate legend 18 may be associated therewith.

A third scale 19, preferably positioned radially inwardly of the scale 15 and opposite the scale 17, may be marked to indicate various numbers of hundreds of tons of paper produced per twenty-four hours, as indicated by the legend 20. The fourth scale 21, comprising elongated radial lines 22, spaced apart in a similar manner, according to the logarithmic scale principle, indicates various numbers of drying rolls employed, from fifty to one hundred, the legend 23 for this scale, however, being positioned upon the rotatable slide 12. The radial lines 22 of the scale 21, for purposes hereinafter described, are intersected by a plurality of arcs 25—29, both inclusive, adapted to constitute continuations of similarly positioned arcs 25*a*—29*a*, both inclusive, on the rotatable slide 12 and each leading to an indicia 30 for a particular steam pressure, as indicated by the legend 31 on the rotatable slide.

The rotatable slide 12 preferably takes the form of a disc made of any suitable sheet material, preferably corresponding to that of the base, and having arcuate peripheral edges 35, 36 struck about the center 11, but spaced different distances therefrom and connected to each other by angular edges 37, 38. The disc also has two arcuate openings or windows 40, 41 formed therein, in order to expose the scales 19 and 21, respectively. The opening 40 is in the form of an elongated concentric arcuate slot, while the opening 41 has one end defined by concentric arcs and another, pointed end defined by an angularly disposed and an arcuate margin, for purposes hereinafter explained.

The upper portion of the disc, in the space between the cut-out 40 and the outer margin 36 is provided with a logarithmic scale 45 having numerals 46 corresponding to various widths of trimmed paper in inches, which may be produced in the mill from one hundred and fifty to two hundred and thirty inches, as indicated by the legend 47. It should be noted that the markings in this scale are the same on both edges and that they are adapted to register with the scales 17 and 19, respectively, indicating the production in tons per hour and in hundreds of tons per twenty-four hours.

The arcuate margin 34 of the disc 12 is provided with a scale 50, having numerals 51 associated therewith, indicating various weights of paper produced in the mill, by the conventional designation of weight per one thousand square feet, as indicated by the legend 53. The markings on the scale 50 are positioned adjacent to and are adapted to register with the markings on the scale 15, indicating the speed of travel of the paper sheet per minute in units of one hundred feet.

As stated above, the disc 12 also carries a column of figures 30 for various roll temperatures, translated into the more convenient form of steam pressure in pounds per square inch, and arcuate lines 25*a*—29*a* lead from these numbers toward the radial lines 22 associated with the drying roll scale 21. The expedient shown has been adopted for convenience, in place of having the steam pressure or temperature scale arranged along an arcuate curve, in a manner similar to the other scales, but it will be noted that each line 25*a*—29*a* terminates on the straight angular edge 55 of the opening 41 at a point disposed on a radius spaced circumferentially from the next adjacent radius in accordance with the spacing of a logarithmic scale. Hence, when any particular point of intersection between a line 25*a*—29*a* and the margin 55 is brought into registration with a radial line 22, corresponding to a particular number of operative drying rolls, the disc is adjusted with respect to the base in the same manner as if an arcuate scale along an inner or outer margin of the cut-out 41 had been provided.

The outer margin of the cut-out 41 is disposed upon concentric inner and outer arcs 56, 57, connected by a straight, angular edge 58, having indicia 59 disposed therealong, representing various efficiencies, as hereinafter explained and as indicated by the legend 60.

It will be noted that the scales for the different variable factors which have a direct relation to each other are disposed in juxtaposition on the base 10 and the rotatable disc 12. The production in tons per hour and in hundreds of tons per twenty-four hours obviously depends upon the width of the paper sheet. Hence, the scale 45, indicating "trim" in inches, is positioned to register with the production rate in tons and hundreds of tons. As a result, for any particular setting of the rotatable disc, corresponding to a particular combination of speed of travel and paper weight, it is possible to read, adjacent the figure corresponding to the trim being produced, the rate of production in tons per hour and hundreds of tons per twenty-four hours.

Similarly, the weight of the paper and the speed of movement of the sheet are in inverse ratio, when the steam pressure and number of rolls are held constant. Therefore, all combinations of weights and speeds may be read at a glance, by comparing the markings on the weight scale 50 with the markings on the speed scale 15.

The number of drying rolls and the temperature of the rolls similarly are in inverse ratio, since as the number of rolls is decreased, the temperature must be increased. Hence, the tem-

perature scale, provided by the points of junction of the lines 25a—29a with the margin 55 of the opening 41, is positioned to register with the scale 21 for the number of drying rolls. For any setting of the rotatable slide, it is, therefore, possible to read all combinations of drying temperatures or steam pressures and numbers of drying rolls.

The manner in which the various scales were computed and laid out will be briefly described. The divisions of the various scales are similar to logarithmic scales on a slide rule, except that they are measured in degrees of a circle instead of in inches. For example, in each of the scales 15 and 17, the graduation marked 2 is placed at 30.1°, from an imaginary starting point, since the logarithm of 2 is 301. Similarly, the graduation marked 3 is placed at 47.7°, corresponding to the logarithmic 477 for the number 3. However, since the spacing of the division and sub-division lines would be quite minute in certain instances, all of the degrees have been multiplied by 3.

The markings in the scale 21 for 50 to 100 driers, both inclusive, correspond to the logarithmic values, as indicated by a particular steam pressure. This value is directly proportional to the number of driers employed, since 100 driers have twice the drying capacity of 50 driers.

The value of the driers is known as the "drying rate" or the amount of paper which can be dried per hour, per square foot of drying surface. Applicant has determined, from experiments conducted and data collected in the past, that the drying rate is equal to the temperature in Fahrenheit degrees multiplied by .0112 minus 1.708. Since the total surface of one 60 inch diameter drier for a trim of one inch is 1.308 square feet, the capacity of a roll in tons per hour equals the drying rate multiplied by 1.308, multiplied by the trim, divided by 2,000, the number of pounds per ton.

The angle of the margin 55 was determined by calculating the number of driers required to dry an equivalent amount of paper at 50 pounds steam pressure and at 25 pounds steam pressure, the intermediate pressures and number of rolls being in direct proportion. For example, a straight line, as indicated at 62 in Figure 3, starting at 50 driers on the 50 pound circular arc would terminate at 63.4 driers on the 25 pound arc because the ratio based on the comparative drying rate is 1.268 and the same ratio prevails for any other combination. This angular cut is used in lieu of a series of lines, similar to line 62, which would otherwise be required on the scale 21.

The indicia 6–25 associated with the "tons per hours" scale 17 have an index value of one, but the numbers below six have been omitted since the range, 6 to 25 tons, represent the extreme limits of production per hour, when the other factors of the scale are considered. The markings in the scale 19, indicating tons per twenty-four hours in hundreds, have a proportional value, so that any reading on the scale 19 is twenty-four times the corresponding reading on the scale 17.

The tonnage produced is the product obtained by multiplying the implied value, obtained from the scale 21 for the number of driers, by the trim, indicated on the trim scale 45. This multiplication is performed mechanically by moving the revolving disc in a clockwise direction until the selected steam pressure arc 25a—29a coincides with the number of drying rolls as indicated by the radial lines 22.

The solution for any trim is found in the scale 17 opposite the number in the scale 45 for the particular trim under consideration. The product represents the addition of the logarithms of the numbers corresponding to the implied value of the driers and the indicated trim. The production in hundreds of tons per twenty-four hours similarly may be ready directly on the scale 19.

The trim scale 45 has an index valve of 100, but the index is omitted since the practical range of trim is 150 to 230 inches, corresponding to 1.5 to 2.3 on the logarithmic scale.

The weight scale 50 is a reverse scale, since the speed of travel of the web, indicated by the speed scale 15, is inversely proportionate. It was simpler to make the scale 50 a reverse scale, although, obviously, the opposite arrangement could be adopted, i. e. making the scale 15 a reverse scale and the scale 50 a normal one. The index value of the scale 50 is 10, but only the portion between 23 and 90 is included, since these figures represent the limits of paper weights in a Fourdrinier kraft board mill of the type with which the embodiment of the invention shown in the accompanying drawings is adapted to be used.

The speed scale 15 has an index value of one, but the index is omitted for similar reasons. The scale was developed directly from the scale 21 for the number of driers and the scale 50 for the weight of paper, excluding the production rate scales 17 and 19 and the trim scale 45 because the implied tonnage of the scale 21 is on the basis of one drier per one inch trim. This value multiplied by the number of driers, multiplied by the factor 200, divided by the sheet weight gives the speed in feet per minute.

The relative positions of the scales 15, 17 and 21 on the base 10 are unimportant and have been selected for convenience and for even distribution of the figures over the base. The scale 19 must be in predetermined relation to the scale 17, since the figures in the scale 19 correspond to a multiple of those in scale 17. In other words, each figure in scale 19 corresponds to the figure in scale 17, radially aligned therewith, when multiplied by 24.

The relation of the scales 45, 50 and 55 to the scales on the base and to each other are of vital importance, once the scales on the base have been positioned in the arbitrarily selected relation to each other. The relative positions of the scales on the slide or disc 12 are determined by working out one or more specific problems, in accordance with the principles and the formula explained below. When these scales have been so positioned in accordance with one or more specific examples, the figures will be accurate for all other combinations of temperatures, numbers of dryers, speeds of movement, weights of paper, trim and production in tons per hour and hundreds of tons per 24 hours.

Obviously, the reverse procedure in laying out the scales could be adopted. That is to say, the scales could first be marked off on the disc, and then applied to the base, by plotting the results of one or more mathematical computations.

The multiplication and division is mechanically performed simultaneously with the setting of the revolving disc for ascertaining the tonnage, as explained above. The speed of movement of the sheet is found on the scale 15 opposite the indicia on the scale 50, corresponding to the selected sheet weight. Also available, without mov-

ing the revolving disc, is the corresponding speed for any sheet weight from 23 to 90 pounds.

The efficiency scale on the angular edge 58 of the window 41 is useful because the calculations of the other scales have been predicated upon 100% efficiency in operation and many driers do not come up to this standard. The figures on this scale are spaced apart as in a logarithmic scale and therefore automatically indicate the designated percentages. This logarithmic scale has numerals associated with the percentages indicated thereon. The marking 100 is located in respect to chart 21 so that it will register initially with the minimum number of driers, which is fifty, when that number of dryers registers with the minimum steam pressure, which is twenty-five pounds. When the radial line representing the number of driers selected coincides with the figure 100 in the scale 59, the efficiency is 100%. The figures 90 and 80 are for the purpose of comparing the performance of existing paper machines with the values established for the production calculator. For example, if a machine with sixty driers and 25 pounds steam pressure is producing 6.79 tons of paper per hour for a trim of 150 inches, the 100% efficiency figure coincides with the radial line for fifty-four driers and the sixty drier radial line coincides with the 90% efficiency figure. Hence, the efficiency is 90%. Also, if the same machine without reference to the tonnage is operating at a speed of 480 feet per minute for a 30 pound sheet, the 54 drier radial line (100% efficiency) coincides with 80. Therefore, the efficiency is 80%. The equivalent speed for 100% efficiency would be 600 feet.

The angular cut, adjacent the efficiency figure, has no particular significance, except that it permits more of the 50 pound circular arc to be visible than would have been the case, had the figures been placed on the periphery of the circle.

It is thought that the operation of the calculator of the present invention will be entirely clear to those skilled in the art from a consideration of the foregoing description. For instance, if it is desired to find the production of paper in tons per hour or tons per twenty-four hours and the speed of movement of the sheet, when the number of driers and steam pressure are known, it is simply necessary to revolve the disc 12 until the line 25*a*—29*a* leading from the steam pressure intersects the line 22 corresponding to the number of driers employed. Adjacent to the scale 45 marked "trim" will be found the production per hour on the scale 17 and per twenty-four hours on the scale 19. Adjacent the figure on the weight scale 50 corresponding to the paper being produced will be found, on the speed scale 15, the figure corresponding to the speed of movement of the paper in feet per minute.

Conversely, when it is desired to find the number of driers and steam pressure required, when the production in tons and the trim are known, it is necessary simply to revolve the disc until the known production and trim coincide. All possible combinations of numbers of driers and steam pressures are indicated by the points of intersection between the various lines 25*a*—29*a* and the lines 22.

If it is desired to find that alternate speeds for various sheet weights, when the speed for a definite sheet weight is known, the disc is rotated until figures for the known speed and sheet weight coincide. Opposite any weight on the scale 50 will be found the corresponding speed, in the scale 15, in feet per minute. In a similar manner, it is possible to read from the speed scale back to the weight scale, to determine various weights of paper that may be produced at different speeds, using any particular combination of temperature and number of driers.

If it is desired to find the efficiency when the production, trim and number of driers are known, the disc should be revolved until the trim and production selected coincide. Adjacent the number of driers actually employed will be found the efficiency in percent.

Similarly, the efficiency may be determined, if the sheet weight, speed and number of driers are known. This is accomplished by revolving a disc until the sheet weight and speed coincide. Adjacent the number of driers will be found the efficiency in percent.

As illustrating the simplicity of calculation with the device of the present invention, as compared with mathematical calculations heretofore employed, a typical mathematical calculation will be explained. To obtain the figure for the tons per hour produced, for a known steam pressure, number of driers and trim, it is necessary to calculate the drying rate, as explained above, by multiplying the temperature times .0112, minus 1.708. The drier surface must also be computed, by multiplying the number of driers by 1.308 and multiplying the product by the trim in inches. In order to calculate the tons per hour, the drying rate must be multiplied by the drier surface and the product divided by 2,000 (pounds per ton).

As explained above, these complicated calculations may be performed mechanically, by the use of the instrument of the present invention by a simple manipulation of the slide, to bring the steam pressure and number of driers into registration. The production may be read on the scale 17, opposite the figure for the trim in inches.

The fundamental equation showing the relationship between various factors involved in this device may be expressed as follows:

$$P=\frac{N\times S\times R\times T}{2{,}000}$$

in which

P=production in tons per hour,
N=the number of dryers,
S=1.308 (surface in square feet of one dryer for each inch of trim),
R=the drying rate (temperature)×(.0112–1.708),
T=the width of the trimmed sheet in inches, and
2,000 stands for pounds per ton.

If we have the problem of determining the production in tons per hour of a paper machine having fifty dryers, each 60 inches in diameter, with fifty pounds steam pressure per square inch therein (temperature 297.7° F.) and 150 inch trim, the problem would be worked as follows:

$$P=\frac{50\times 1.308\times 1.6262\times 150}{2{,}000}=7.977$$

The difficulties in performing the multiplications and division required in solving this problem are obvious. To solve the same problem by the calculator of the present invention, the fifty pound steam pressure on scale 55 is set to coincide with the 50 dryer figure in scale 21. By reading the number in scale 17 opposite the indicia corresponding to 150 in the trim scale 47, the answer is found. Without changing the setting of the disc, the production in 24 hours may be deter-

mined, by reading the figure in the scale 19, opposite the 150 trim figure.

Another formula showing the relation between the speed of movement of the sheet in 100 feet per minute, the weight of the paper, per 1,000 square feet, and the tons per hour and trim in inches may be expressed as follows:

$$S=\frac{P\times 2{,}000\times K}{W\times T}$$

in which

S=speed per minute in 100 feet,
2,000=pounds per ton,
K a constant=200 for 1,000 square feet basis,
W=weight of sheet in pounds per square feet, and
T=trim in inches.

The mathematical calculations required to reduce this formula are somewhat involved, but they may be automatically performed by simply setting one pair of known figures in the problem, whereupon the unknown may be read opposite the third known quantity. For instance, if the trim and the paper weight are known, as well as the speed in feet per minute, the production figures per hour or 24 hours may be determined by adjusting the weight and speed figures and reading the production opposite the number trim. Similarly, if a predetermined production schedule must be met, for a known weight and trim of paper, the speed may be determined by adjusting the production rate (tons per hour) and the trim to correspond, whereupon the speed in 100 feet per minute may be determined by reading the figure in the scale 15 opposite to the known weight in scale 50.

It must be understood that the invention is not limited to the details of construction shown in the accompanying drawings and described above, since the principles of invention may be embodied in many modified forms. All devices coming within the scope of the appended claims and their equivalents are intended to be included.

I claim:

1. A calculator for solving problems in the manufacture of paper involving variables relating to rate of production in weight, number of driers, temperature of driers, width of paper and speed of movement of the sheet, having the relation expressed by the formula

$$P=\frac{N\times S\times R\times T}{2{,}000}$$

in which

P=production in tons per hour,
N=the number of driers,
S=.1308 (surface in square feet of each 60 inch drier for each inch of trim),
R=the drying rate (temperature in degrees Fahrenheit ×.0112–1.708),
T=the width of the trimmed sheet in inches, and
2,000=pounds per ton,

said calculator comprising a base having logarithmic scales arranged on arcs of progressively larger concentric circles, the innermost scale corresponding to numbers of driers, the next outer scale corresponding to speeds of movement of the sheet, and the outermost scale corresponding to rates of production in tons per unit of time, and a slide mounted for rotation on the center of said concentric circles and having margins registering with the scales on the base and logarithmic scales along said margins corresponding respectively with the temperatures or steam pressures of the rolls, the weights of the paper and the trim of the paper, the scales being so arranged that, for a setting of any one pair of variables represented by a scale on the base and the adjacent scale on the slide, a plurality of other corresponding pairs of variables are indicated in the two other sets of scales on the base and slide, respectively, the slide having a generally arcuate opening therein, exposing the innermost, number of driers, scale on the base, said opening being defined at one end by a straight line margin disposed at an oblique angle to a radius of the slide, the temperature or steam pressure scale being arranged along said straight line margin in position to register with the number of driers scale therebelow.

2. A calculator for solving problems in the manufacture of paper involving variables relating to rate of production in weight, number of driers, temperature of driers, width of paper and speed of movement of the sheet, having the relation expressed by the formula

$$P=\frac{N\times S\times R\times T}{2{,}000}$$

in which

P=production in tons per hour,
N=the number of driers,
S=.1308 (surface in square feet of each 60 inch drier for each inch of trim),
R=the drying rate (temperature in degrees Fahrenheit×.0112–1.708),
T=the width of the trimmed sheet in inches, and
2,000=pounds per ton,

said calculator comprising a base having logarithmic scales arranged on arcs of progressively larger concentric circles, the innermost scale corresponding to numbers of driers, the next outer scale corresponding to speeds of movement of the sheet, and the outermost scale corresponding to rates of production in tons per unit of time, and a slide mounted for rotation on the center of said concentric circles and having margins registering with the scales on the base and logarithmic scales along said margins corresponding respectively with the temperatures or steam pressures of the rolls, the weights of the paper and the trim of the paper, the scales being so arranged that, for a setting of any one pair of variables represented by a scale on the base and the adjacent scale on the slide, a plurality of other corresponding pairs of variables are indicated in the two other sets of scales on the base and slide, respectively, the slide having a generally arcuate opening therein exposing the innermost number of driers scale on the base, the scale for temperature or steam pressure being arranged along a margin of said opening in position to register with the number of driers scale therebelow.

3. A calculator for solving problems in the manufacture of paper involving variables relating to rate of production in weight, number of driers, temperature of driers, width of paper and speed of movement of the sheet, having the relation expressed by the formula

$$P=\frac{N\times S\times R\times T}{2{,}000}$$

in which

P=production in tons per hour,
N=the number of driers,
S=.1308 (surface in square feet of each 60 inch drier for each inch of trim),
R=the drying rate (temperature in degrees Fahrenheit×.0112–1.708),
T=the width of the trimmed sheet in inches, and
2,000=pounds per ton,

said calculator comprising a base having logarithmic scales arranged on arcs of progressively larger concentric circles, the innermost scale corresponding to numbers of driers, the next outer scale corresponding to speeds of movement of the sheet, and the outermost scale corresponding to rates of production in tons per unit of time, and a slide mounted for rotation on the center of said concentric circles and having margins registering with the scales on the base and logarithmic scales along said margins corresponding respectively with the temperatures or steam pressures of the rolls, the weights of the paper and the trim of the paper, the scales being so arranged that, for a setting of any one pair of variables represented by a scale on the base and the adjacent scale on the slide, a plurality of other corresponding pairs of variables are indicated in the two other sets of scales on the base and slide, respectively, the slide having a generally arcuate opening therein exposing the innermost number of driers scale on the base, the scale for temperature or steam pressure being arranged along a margin of said opening in position to register with the number of driers scale therebelow, the slide having other outer margins disposed on arcs of concentric circles, with the weight scale along the margin of less radius in position to register with the speed of movement scale, and the trim scale along the margin of greater radius in position to register with the rate of production scale.

HARVEY G. McDOWELL.